

# Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.



# U. S. NO. 5 REFUGEE, A NEW MOSAIC-RESISTANT REFUGEE BEAN

By B. L. WADE, *senior geneticist*, and W. J. ZAUMEYER, *pathologist*, *Division of Fruit and Vegetable Crops and Diseases, Bureau of Plant Industry*

## CONTENTS

	Page		Page
Introduction.....	1	Tests under commercial conditions.....	7
Parentage.....	1	Discussion and comparisons.....	0
Characteristics.....	1	Seed supplies.....	11
Technical description.....	2	Summary and conclusions.....	11
Experimental results.....	4		

## INTRODUCTION

In the fall of 1935 the U. S. No. 5 Refugee, a mosaic-resistant bean of the Stringless Green Refugee type, was released to the seed trade by the United States Department of Agriculture. This variety is the result of a cross between U. S. No. 1 Refugee and a rogue strain of Stringless Green Refugee that has been referred to as Corbett Refugee.

## PARENTAGE

U. S. No. 1 Refugee, the female parent, is tolerant to the common bean mosaic under field conditions. The plants are of a sturdy bush type with nearly round, stringless pods, slightly darker green than Stringless Green Refugee. It is very prolific, somewhat drought-tolerant, and from 10 to 14 days earlier than Keeney Stringless Green Refugee.

The male parent, a rogue strain of Stringless Green Refugee, is indeterminate in growth habit. Although the foliage is typical of Stringless Green Refugee, the plant has weak tendrils that may reach a length of over 3 feet, as in such varieties as the Great Northern. The pods are short and not quite round. Although variable in some characters, it is completely resistant to common bean mosaic.

## CHARACTERISTICS

The U. S. No. 5 Refugee is very similar to Stringless Green Refugee in plant and pod characters, and in addition it is apparently immune to common bean mosaic. The plants are large, spreading, slightly indeterminate bushes. The tendrils are shorter than those of most strains of Stringless Green Refugee, but the leaf characters and the general appearance of the plant are very similar to typical Stringless

Green Refugee. The plant is very prolific and produces straight, long, round, stringless pods of excellent flavor and quality. The pods are slightly longer than those of Stringless Green Refugee, but they are without the purple splashing characteristic of that variety. Because of this lack of splashing U. S. No. 5 Refugee is of promise as a market-garden bean as well as for canning. The flowers are white with only an occasional trace of pink. It is easy to distinguish U. S. No. 5 Refugee from other Refugees even in the blooming stage, since all other Refugees so far introduced have purplish blossoms.

U. S. No. 5 Refugee is approximately 1 week earlier than Keeney Stringless Green Refugee. Earliness is of importance in canning areas where Stringless Green Refugee does not mature its entire crop or because the canners are unable to obtain pickers late in the season.

In some crosses involving strains of Corbett Refugee as one parent there have appeared deformities somewhat resembling a virus disease. There is some evidence to indicate that they are chimeras. In experimental plantings of U. S. No. 5 Refugee no such deformities have ever been found, and seedsmen have not reported their occurrence in this variety.

It seems important to point out that although U. S. No. 5 Refugee is completely resistant to the virus of common bean mosaic, it is not resistant to the virus of yellow bean mosaic (white sweetclover mosaic), which sometimes occurs both in seedsmen's and in canners' fields, but has so far not caused any serious damage. Common bean mosaic is seed-borne, while yellow bean mosaic is not.

Figure 1 shows pods of U. S. No. 5 Refugee in comparison with pods of the Keeney and Rogers strains of Stringless Green Refugee.

Figure 2 shows a normal in comparison with a mosaic-infected Keeney Stringless Green Refugee plant.

#### TECHNICAL DESCRIPTION

Plants dwarf, erect, large, 35 to 46 cm (14 to 18 inches) high, with spread of 38 to 46 cm (15 to 18 inches); spreading but compact, without runners, although some indeterminate shoots and some branches resemble weak tendrils, especially in thin stands; vigorous, productive over a long season. Stems stout, nearly round; lower internodes smooth, upper internodes ridged; internodes short; branches and secondary branches numerous, green throughout. Foliage dense, medium to dark green, bright; leaves nearly smooth, thin, very slight pubescence; typical of Stringless Green Refugee, small, 11.4 cm (4½ inches) long, 6.4 cm (2½ inches) wide, relatively long, slender, approaching diamond shape, point tapering. Flowers white; may be very slightly pink-tinged when older.

Pods hanging somewhat below foliage; light, pale green in color; <sup>1</sup> brittle, finely textured, without strings, and with very little fiber; medium long, slender (fully developed fancy canning pods 14 by 0.8 by 0.8 cm = 5½ by ⅝ by ⅝ inches), containing five to seven seeds per pod; round; nearly circular in cross section, straight-backed, occasionally very slightly curved, regular, filled to tip and edge, smooth, seeds not crowded; pod rounded at distal end, spur long, slender and very slightly recurved; placental suture slightly indented and carpellary suture rounded.

Seeds medium size, 1.3 by 0.55 by 0.55 cm (½ by ⅞ by ⅞ inch), 105 per ounce; quite straight, cylindrical, tapering slightly to ends, plump, ends rounded; hilum small, flat; seed coat color dun (11 G-7),<sup>2</sup> splashed and mottled over the entire surface with brown (briarwood 8 J-6).<sup>2</sup>

<sup>1</sup> Similar to Stringless Green Refugee.

<sup>2</sup> MAERZ, A., and PAUL, M. REA. A DICTIONARY OF COLOR. 207 pp., illus. New York. 1930. [References are to plate, column, and row; e. g., 11 G-7 refers to plate 11, column G, row 7.]

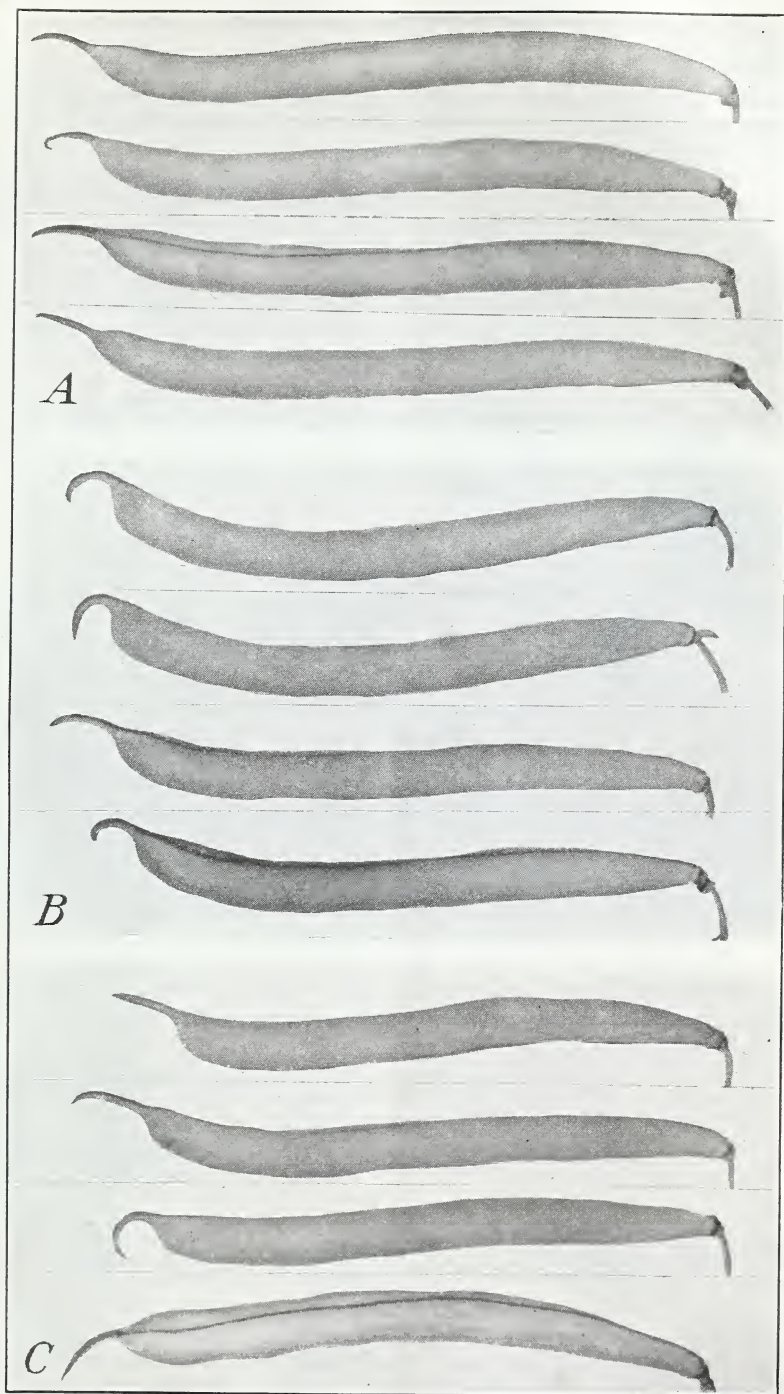


FIGURE 1.—Typical pods of (A) U. S. No. 5 Refugee, (B) Keeney Stringless Green Refugee, and (C) Rogers Stringless Green Refugee.

## EXPERIMENTAL RESULTS

Beginning in 1935, various experiments have been conducted to measure differences in U. S. No. 5 Refugee as compared with other strains of Stringless Green Refugee. Table 1 shows the results obtained in the summer of 1935 at Greeley, Colo. This was a year in which practically no damage from mosaic occurred in Colorado and both types of Stringless Green Refugee outyielded U. S. No. 5 Refugee. Keeney Stringless Green Refugee gave a significantly higher yield than U. S. No. 5 Refugee or Rogers Stringless Green Refugee, but the difference between U. S. No. 5 Refugee and Rogers Stringless Green Refugee was not significant. Even during years in which severe epidemics of common bean mosaic occur on susceptible varieties in Colorado the infection occurs so late in the season that yields usually



FIGURE 2.—Normal (a) and mosaic-infected (b) plants of Keeney Stringless Green Refugee.

are not much reduced. However, in New York and Wisconsin mosaic infection ordinarily takes place early enough in the season to cause great reduction in yields.

TABLE 1.—Yield of 3 varieties of snap beans, Greeley, Colo., 1935

Variety	Reaction to common bean mosaic	Average acre yield of 4 plots	Standard error, mean of 4 plots	Minimum significant difference
Keeney Stringless Green Refugee.....	Susceptible.....	<i>Pounds</i> 16,373	<i>Pounds</i>	<i>Pounds</i>
Rogers Stringless Green Refugee.....	do.....	13,704		
U. S. No. 5 Refugee.....	Resistant.....	12,727	806.45	2,281

Since Rogers Stringless Green Refugee and U. S. No. 5 Refugee are ready for picking at the same time, pod measurements were made during the summer of 1935 at Greeley, Colo., to determine the average pod lengths. From comparable areas in the field, plants showing no

insect or disease damage were taken at random and all pods on each plant measured. This procedure caused the average pod length to appear somewhat less than is typical, since some small pods that would not have been picked by canners were picked and measured. The Rogers Stringless Green Refugee had a mean pod length of 3.66 and U. S. No. 5 Refugee of 3.84 inches. As calculated by variance analysis, the odds are about 44:1 that there is an actual difference in the pod lengths of the two varieties.

When breeding work was started on U. S. No. 5 Refugee, Keeney Stringless Green Refugee, requiring about 70 days from planting to first picking for canning, was the standard Refugee. Since then a very satisfactory strain, Rogers Stringless Green Refugee, requiring about 63 days to first picking, has gained popularity. In addition, the Idaho and Wisconsin mosaic-resistant Refugee strains of 64 and 70 days, respectively, were introduced in 1934. It was thought advisable to include all five types in these studies of yield and canning characteristics, because of the keen current interest in them.

In 1936 and 1937 U. S. No. 5 Refugee was grown at Greeley, Colo., in quadruplicate plots in comparison with the two mosaic-susceptible strains of Stringless Green Refugee and with the Idaho and Wisconsin mosaic-resistant strains of Refugee. The susceptible strains used are believed to be the most widely used strains of susceptible Refugee now grown in the United States. Two rows of each variety were grown in each series. One row was harvested for seed, the other for snap beans. Mosaic was very slight in 1936 but abundant in 1937; however, no serious damage occurred to any of the varieties in the test. Although U. S. No. 5 Refugee gave the highest average yield of snap beans, none of the differences obtained are significant for either snap or seed beans. The average yields for four plots of each variety grown in 1936 and in 1937 and the 2-year average of snap and of shell beans are shown in table 2.

TABLE 2.—Yield of snap and seed beans, Greeley, Colo., 1936 and 1937

Variety	Reaction to common bean mosaic	Average acre yield of snap beans for years indicated			Average acre yield of seed beans for years indicated		
		1936	1937	Average	1936	1937	Average
U. S. No. 5 Refugee	Resistant	Pounds 10,031	Pounds 9,439	Pounds 9,735	Pounds 1,203	Pounds 1,159	Pounds 1,181
Keeney Stringless Green Refugee	Susceptible	9,163	9,329	9,246	1,147	1,033	1,090
Rogers Stringless Green Refugee	do	9,765	8,689	9,227	1,173	1,328	1,250
Idaho Refugee	Resistant	10,159	7,974	9,066	1,039	1,217	1,128
Wisconsin Refugee	do	7,443	9,386	8,414	1,282	1,475	1,378

NOTE.—S. E. of mean of 8 plots, snap beans, 440 pounds; seed beans, 85 pounds. *F* values indicate no significant differences.

In 1936, C. B. Sayre, of the New York State Agricultural Experiment Station, grew U. S. No. 5 Refugee in comparison with other Refugee beans near Geneva, N. Y. U. S. No. 5 Refugee gave an average yield in three plots of 1,452 pounds per acre more than Keeney Stringless Green Refugee. The yield of U. S. No. 5 was 7,950 pounds, of Keeney Stringless Green Refugee 6,498, and of Idaho Refugee 8,399 pounds of snap beans per acre. The yield differences are not statistically significant.

During harvest of snap beans at Greeley, Colo., in the summer of 1937 a representative sample was taken from each of the four plots of each of the five varieties tested, and measurements of the width, thickness, length, and curved length were made on pods taken without selection. In addition, an index of rotundity was calculated by dividing thickness by width, and an index of curvature by dividing the curved length by the length. Length of pod was recorded as the distance from the lower portion of the calyx cap to the beginning of the spur and was made without stretching or interfering with the normal curvature of the pod. The curved length measurement was made between the same two points, but a string was fitted to the dorsal suture and the required string length recorded.

Tables 3 and 4 show the averages of these measurements based on 31 pods per strain per picking, or a total of 310 pods for each of the six measurements.

U. S. No. 5 Refugee was not quite so wide (suture to suture) as any of the other four varieties. It was not significantly narrower than Idaho and Wisconsin Refugees, but was significantly narrower than both strains of Stringless Green Refugees.

TABLE 3.—*Width, thickness, and index of rotundity (thickness divided by width) of strains of Refugee snap beans grown at Greeley, Colo., 1937*

[31 bean pods per strain measured at each picking]

Variety	Width			Thickness			Rotundity index		
	First picking	Second picking	Average	First picking	Second picking	Average	First picking	Second picking	Average
U. S. No. 5 Refugee.....	<i>Cm</i> 0.93	<i>Cm</i> 0.95	<i>Cm</i> 0.94	<i>Cm</i> 0.99	<i>Cm</i> 0.95	<i>Cm</i> 0.97	1.07	1.00	1.03
Idaho Refugee.....	.94	.98	.96	.96	.94	.95	1.01	.95	.98
Rogers Stringless Green Refugee.....	.98	1.02	1.00	.98	.93	.96	1.00	.92	.96
Wisconsin Refugee.....	.95	.97	.96	.88	.93	.91	.93	.96	.95
Keeney Stringless Green Refugee.....	1.00	1.04	1.02	.99	.97	.98	.98	.93	.96

$F_v=10.47$  for width, 6.77 for thickness, 18.43 for rotundity index.

S. D.=0.08 for width, 0.08 for thickness, 0.07 for rotundity index.

S. E.,  $M_{62}=0.01$  for width, 0.01 for thickness, 0.01 for rotundity index.

Significant difference=0.03 for width, 0.03 for thickness, 0.02 for rotundity index.

TABLE 4.—*Length, curved length, and curvature index (curved length divided by length) of strains of Refugee snap beans grown at Greeley, Colo., 1937*

[31 pods per strain measured at each picking]

Variety	Length			Curved length			Curvature index		
	First picking	Second picking	Average	First picking	Second picking	Average	First picking	Second picking	Average
U. S. No. 5 Refugee.....	<i>Cm</i> 10.81	<i>Cm</i> 10.27	<i>Cm</i> 10.54	<i>Cm</i> 11.59	<i>Cm</i> 10.90	<i>Cm</i> 11.25	1.07	1.06	1.07
Idaho Refugee.....	9.78	9.90	9.84	10.74	10.55	10.64	1.10	1.07	1.08
Rogers Stringless Green Refugee.....	9.81	9.99	9.90	10.53	10.84	10.69	1.07	1.08	1.08
Wisconsin Refugee.....	9.15	9.07	9.11	9.85	9.94	9.89	1.08	1.10	1.09
Keeney Stringless Green Refugee.....	10.32	10.22	10.27	11.36	11.01	11.19	1.10	1.08	1.09

$F_v=33.02$  for length, 25.95 for curved length, 2.45 for curvature index.

S. D.=0.74 for length, 0.84 for curved length, 0.04 for curvature index.

S. E.,  $M_{62}=0.09$  for length, 0.11 for curved length, 0.01 for curvature index.

Significant difference=0.27 for length, 0.30 for curved length, 0.02 for curvature index.

Measurements of thickness (at right angles to width) indicated that Wisconsin Refugee was significantly thinner than any other strain. Keeney Stringless Green Refugee had an average thickness of 0.98 and U. S. No. 5 Refugee of 0.97 cm, an insignificant difference.

The rotundity index  $\frac{(T)}{W}$  indicated that U. S. No. 5 was slightly crease-backed—an indication of a close approach to roundness in the early stages. U. S. No. 5 Refugee had a significantly higher rotundity index than any other variety included.

Normal length measurements indicated that U. S. No. 5 Refugee was significantly longer than any of the other four strains. In the case of Keeney Stringless Green Refugee the difference was slight, but Wisconsin Refugee was 1.43 cm shorter for the average of two pickings.

Curved length measurements showed that U. S. No. 5 Refugee had a significantly longer pod than the other Refugees except Keeney Stringless Green Refugee.

Curvature index calculations showed U. S. No. 5 Refugee to be the least curved of any variety measured, but not significantly less curved than Idaho Refugee or Rogers Stringless Green Refugee. In the case of Keeney Stringless Green Refugee and Wisconsin Refugee, the differences in comparison with U. S. No. 5 Refugee were significant.

On 100 pods of each strain taken at random the percentage of pods showing a trace or more of splashing with purple pigment was as follows: U. S. No. 5 Refugee, 0; Idaho Refugee, 62; Rogers Stringless Green Refugee, 53; Wisconsin Refugee, 55; Keeney Stringless Green Refugee, 45. It is realized that splashing is quite variable and much influenced by environmental conditions. Intensity of splashing on Wisconsin Refugee was adjudged to be greater than on any other variety included, but the intensity was not measured.

The foregoing measurements confirm the writers' observations as well as those of some seedsmen and canners that U. S. No. 5 Refugee is more nearly round than the average Refugee, the pods slightly longer, less curved, and more slender. It is of course understood that length, rotundity, and curvature are in part a result of the environment, and under some other conditions the above-mentioned relationships might be somewhat changed.

#### TESTS UNDER COMMERCIAL CONDITIONS <sup>3</sup>

C. B. Sayre has reported the general reaction of 23 representatives of well-known canning companies in New York State who examined canned samples of U. S. No. 5 Refugee in comparison with several other varieties of snap beans grown in 1936 at the New York State Agricultural Experiment Station at Geneva. U. S. No. 5 Refugee was unanimously rated first in quality, and there were no objections to its color. Its tenderness and fine flavor were especially mentioned.

Sayre has also stated that in this 1 year's test the variety appeared well adapted to New York conditions and that seed should be made generally available in commercial quantities as promptly as the seed trade can do so. He noted that U. S. No. 5 Refugee was about 3 days earlier than Idaho Refugee and a week earlier than Stringless Green

<sup>3</sup> All reports referred to in this section are unpublished statements and data supplied to the writers by correspondence. The writers gratefully acknowledge the information and comments submitted by experiment station workers and members of the seed and canning industries.

Refugee, and that although it appeared a trifle lighter in color than common Refugee, it had been mixed with common Refugee in a commercial pack with no noticeable effect resulting from its color. Its lack of purple splashing on the pods indicated a possible value as a market bean.

J. C. Walker reports that in 1 year's trials at the Wisconsin Agricultural Experiment Station, U. S. No. 5 Refugee and Idaho Refugee yielded at about the same rate in 1937, viz, 4,931 and 4,883 pounds of snap beans per acre, respectively. Wisconsin Refugee and Stringless Green Refugee yielded 3,058 and 2,160 pounds per acre, respectively.

A large canning company in Michigan reports that they are well pleased with U. S. No. 5 Refugee, since the pods have a good color, are round (no flat pods found), and are of a long, narrow type that they desire in their canning operations. No mosaic was found in the strain. Time of maturity is about the same as the Stringless Green Refugee, which they have been using.

A large western firm that is engaged in canning and seed production was well pleased with U. S. No. 5 Refugee as it grew under Utah conditions. They believe it is good for a 50-percent increase in yield over Stringless Green Refugee in years of heavy mosaic infection. They stated that in one test, plots containing 117 plants each of Stringless Green Refugee and of U. S. No. 5 Refugee gave yields of 56.5 and 86.5 pounds, respectively. The harvest peak of U. S. No. 5 Refugee was 10 days earlier than that of Stringless Green Refugee. A representative of the firm wrote: "In comparative mosaic resistance the No. 5 Refugee showed 3.2 percent infection compared to practically 100 percent in the checks, 51 percent in the Wisconsin Refugee, and 50 percent in the Idaho." These figures represented percentage of plants showing symptoms without regard to the severity of effects of mosaic. He also raised the following question: "I wonder if there is a possibility of some other mosaic virus being involved, one that would be indistinguishable from the common bean mosaic. Whatever else is involved, U. S. No. 5 Refugee is evidently resistant to it." It is quite possible that yellow bean mosaic was abundant in this instance. It is practically impossible for anyone to differentiate between common and yellow bean mosaic under ordinary field conditions. The actual damage from mosaic in U. S. No. 5 Refugee, Wisconsin Refugee, and Idaho Refugee was very slight.

The U. S. No. 5 Refugee was found by the last-mentioned firm to be very uniform in shape and size, but was lighter in color than Stringless Green Refugee in the field. In the canned samples the difference in color was not very evident and was considered to be of no importance. In general quality and appearance it was judged to be superior to other strains of Refugee that are resistant to common bean mosaic.

A large seed company reports that in its Michigan trials of U. S. No. 5 Refugee yields of 25 to 30 bushels of seed per acre were obtained. This company wrote:

We are inclined to believe that the usefulness of this bean for canning depends more on its productive ability than on its color. If it should produce every season as it did for us this year, we think it will be popular with the canners who pack the Refugee type bean. We ourselves are very favorably impressed with this variety.

Two other large seed companies are well impressed by the type and high quality of U. S. No. 5 Refugee but are skeptical about the desirability of a variety the pods of which are slightly lighter green than Stringless Green Refugee.

J. G. Leach, of the Division of Plant Pathology and Botany, University of Minnesota, reports that U. S. No. 5 Refugee showed about 3 or 4 percent of mosaic in his 1937 trials. (He apparently did not differentiate between common bean mosaic and yellow bean mosaic, the latter of which affects all strains discussed in this circular. As mentioned before, these two mosaics appear alike in the field.) He also observed that the variety was strikingly resistant to leaf-hopper injury in those particular trials.

### DISCUSSION AND COMPARISONS

To facilitate a comparison of the different types of Refugee beans tested, the characteristics of the five strains are shown in table 5.

TABLE 5.—*Comparison of characteristics of five varieties of Refugee type of snap bean*

Characteristics	U. S. No. 5 Refugee	Idaho Refugee	Rogers String- less Green Refugee	Wisconsin Refugee	Keeney String- less Green Refugee
Type of plant	Slightly in- determi- nate bush.	Slightly in- determi- nate bush.	Slightly in- determi- nate bush.	Slightly in- determi- nate bush.	Slightly in- determi- nate bush.
Seed size (number of seeds per ounce)	105	98	95	97	96
Color of mottling of seed coat	Brown	Purple	Purple	Purple	Purple
Reaction to mosaic (com- mon)	Resistant	Resistant	Susceptible	Resistant	Susceptible
Time to first picking, days	62	64	63	70	70
Pod lengths <sup>1</sup> , inches	5½	5¾	5 to 5¾	5 to 5¼	5 to 5½
Splashing of pods	None	Splashed	Splashed	Heavily splashed.	Splashed
Color of pods	Light green	Light green	Light green with slight yellowish.	Medium light green.	Light green.
Pod straightness	Most nearly straight.	Nearly straight.	Nearly straight.	Nearly straight.	Slightly curved.
Pod roundness	Most nearly round.	Nearly round.	Nearly round.	Slightly oval.	Nearly round.
Pod slenderness	Very slender	Slender	Slender	Slender	Slender

<sup>1</sup> Pod lengths as given by seedsmen for the finest pods available.

The Stringless Green Refugee snap bean is considered by many seedsmen and canners to be the finest bean grown for canning and nearly ideal. Consequently, improvements involving changes in pod type and quality must be slight, and to measure differences it is necessary to use relatively large numbers of individuals. There are, however, at least four slight improvements that some canners and seedsmen have desired in Refugee pods, namely: (1) Elimination of the purple splashing that occurs on about half the pods of Stringless Green Refugee; (2) less tendency to curve; (3) slightly longer pods for whole-pack beans; and (4) a closer approach to roundness in the early stages. No bean pods are perfectly round in the young stages, but they tend to approach more nearly to roundness with age. Canners commonly consider that a snap bean can be sold as round if the ratio  $\left(\frac{T}{W}\right)$  of the width (suture to suture) to thickness (at right angles

to the suture to suture measurement) is greater than 0.80. However, they do consider that the more nearly this ratio approaches 1.00 in small beans the more satisfactory is the bean from the standpoint of appearance. If the ratio exceeds 1.00 (i. e., slightly crease-backed in later stages) there is no objection and it is taken as an indication that the younger beans will be more nearly round in cross section.

The seed of U. S. No. 5 Refugee is slightly smaller than that of Keeney Stringless Green Refugee, 1 ounce of each containing 105 and 96 seeds, respectively.

The brown mottling of the seed coat of U. S. No. 5 Refugee appears to be a distinct advantage to seedsmen in helping them to keep it separated from other Refugee stocks. In addition, the intensity of the brown color develops relatively later in U. S. No. 5 Refugee than that of the purple color in the other Refugees; so that canned cut beans show very little coloration of the seed.

From the data presented it would seem that under very favorable growing conditions where mosaic is not a factor in reducing yields, U. S. No. 5 Refugee may at times yield less than Keeney Stringless Green Refugee. However, most of the increased yield of Keeney Stringless Green Refugee over U. S. No. 5 Refugee under favorable conditions is without practical value, since with the opening of schools and with competition for labor for the harvesting of other crops many canners rarely attempt to get the last possible picking from their Refugees. Refugee seed has fluctuated somewhat violently in price on account of shortages following early fall frosts and other unfavorable weather in seed-growing areas. It is believed that the introduction of earlier strains is beneficial alike to canners, seedsmen, and farmers.

It is believed that the characteristics possessed by U. S. No. 5 Refugee should help to reduce the cost of canning a fancy whole bean for the following reasons:

- (1) There will be no loss from common bean mosaic.
- (2) Straightness of pods should reduce snipping costs, since beans that are straight require less time in the snippers than do curved beans.
- (3) Pod lengths are such that it is not difficult to obtain beans satisfactory for a whole pack.
- (4) Purple splashing has been eliminated, so that it is not necessary to blanch so long as with other Refugees. Not only may canning operations be speeded up, but losses in grade from overblanching are avoided. U. S. No. 5 Refugee will withstand the longer periods of blanching, but such periods are obviously unnecessary.
- (5) A closer approach to roundness in the early stages helps to give the product a fancy quality.
- (6) Slender pods make it possible to can slightly more fancy pods from a given weight of beans.

Some canners have found that U. S. No. 5 Refugee can be mixed with Stringless Green Refugee without loss of grade on the mixed pack; other canners and seedsmen have found that it is very slightly lighter green than Stringless Green Refugee. Attempts have been made to distinguish U. S. No. 5 Refugee from other Refugees in the above-mentioned experiments by means of color standards,<sup>1</sup> but not enough greens are available in the plates to enable one to identify differences between the strains. However, it is the opinion of the writers that U. S. No. 5 Refugee is very slightly lighter green than the others, followed closely by Idaho Refugee, Keeney Stringless

<sup>1</sup> MAERZ, A. J., and PAUL, M. R. See footnote 2.

Green Refugee, and Rogers Stringless Green Refugee in the order of increasing color. Wisconsin Refugee is somewhat darker than the other four. A word of precaution in observing the colors is necessary, since all Refugees become lighter green with age, and it is consequently necessary to make comparisons between pods of the same developmental age. Rogers Stringless Green Refugee has a slight tinge of yellowness in the uncooked pods, which disappears with blanching. If a canned product of U. S. No. 5 Refugee exactly the same shade of green as Keeney or Rogers Stringless Green Refugees is desired, it can be obtained by a slight reduction in time of blanching.

Some observers have found U. S. No. 5 Refugee to be apparently more susceptible to bacterial blight than some other strains of Refugee beans. For such observations to be accurate they should be based on seed stocks from the same growing area. Practically all comparisons so far made have been with Colorado-grown U. S. No. 5 Refugee in comparison with Idaho-grown strains of other Refugees. Nearly every year there is at least a mild infection of bacterial blight in Colorado, where the experimental stocks were grown, while the disease is rare in most bean-growing districts of Idaho. In making this comparison at Charleston, S. C., U. S. No. 5 Refugee remained relatively less injured by bacterial blight than did the Idaho-grown Refugee strains with which it was compared. This was probably due, however, to the greater vigor of U. S. No. 5 Refugee rather than to any greater tolerance to blight. All canning stocks of Refugee are apparently tolerant to bacterial blight. Although a small percentage of plants may be killed by seed-borne infections and considerable areas of the leaves become brown, it is rare for lesions of bacterial blight to be found on the pods of the various strains of Refugee beans.

### SEED SUPPLIES

The United States Department of Agriculture has no seed of this variety for sale in any amounts and does not have quantities for general distribution for commercial tests. A number of commercial seedsmen, including some of those who specialize in the production of beans and peas, are developing commercial supplies of the variety. It is probable that only limited quantities will be available commercially in 1938, but it is expected that ample supplies should be available in succeeding years.

### SUMMARY AND CONCLUSIONS

A new mosaic-resistant Refugee type of bean, designated as U. S. No. 5 Refugee, was introduced in 1935 and has since been given rather extensive tests.

Its superiority over other Refugee beans is believed to consist in (1) resistance to common bean mosaic, amounting to immunity; (2) greater pod length; (3) less pod curvature; (4) distinctive seed; (5) greater tendency for small-sized pods to approach roundness; (6) freedom from purple splashing, so that less blanching is required; and (7) 8 days' earlier development than Keeney Stringless Green Refugee.

Yield tests have indicated that the expected yield is about that of other Refugees, except that where common bean mosaic is a factor it can be depended on to outyield mosaic-susceptible Refugees.

108

## ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE WHEN THIS PUBLICATION WAS LAST PRINTED

---

<i>Secretary of Agriculture</i> .....	HENRY A. WALLACE.
<i>Under Secretary</i> .....	M. L. WILSON.
<i>Assistant Secretary</i> .....	HARRY L. BROWN.
<i>Coordinator of Land Use Planning and Director of Information</i> .....	M. S. EISENHOWER.
<i>Director of Extension Work</i> .....	C. W. WARBURTON.
<i>Director of Finance</i> .....	W. A. JUMP.
<i>Director of Personnel</i> .....	ROY F. HENDRICKSON.
<i>Director of Research</i> .....	JAMES T. JARDINE.
<i>Solicitor</i> .....	MASTIN G. WHITE.
<i>Agricultural Adjustment Administration</i> .....	H. R. TOLLEY, <i>Administrator</i> .
<i>Bureau of Agricultural Economics</i> .....	A. G. BLACK, <i>Chief</i> .
<i>Bureau of Agricultural Engineering</i> .....	S. H. McCROBY, <i>Chief</i> .
<i>Bureau of Animal Industry</i> .....	JOHN R. MOHLER, <i>Chief</i> .
<i>Bureau of Biological Survey</i> .....	IRA N. GABRIELSON, <i>Chief</i> .
<i>Bureau of Chemistry and Soils</i> .....	HENRY G. KNIGHT, <i>Chief</i> .
<i>Commodity Exchange Administration</i> .....	J. W. T. DUVEL, <i>Chief</i> .
<i>Bureau of Dairy Industry</i> .....	O. E. REED, <i>Chief</i> .
<i>Bureau of Entomology and Plant Quarantine</i> .....	LEE A. STRONG, <i>Chief</i> .
<i>Office of Experiment Stations</i> .....	JAMES T. JARDINE, <i>Chief</i> .
<i>Farm Security Administration</i> .....	W. W. ALEXANDER, <i>Administrator</i> .
<i>Food and Drug Administration</i> .....	WALTER G. CAMPBELL, <i>Chief</i> .
<i>Forest Service</i> .....	FERDINAND A. SILCOX, <i>Chief</i> .
<i>Bureau of Home Economics</i> .....	LOUISE STANLEY, <i>Chief</i> .
<i>Library</i> .....	CLARIBEL R. BARNETT, <i>Librarian</i> .
<i>Bureau of Plant Industry</i> .....	E. C. AUCHTER, <i>Chief</i> .
<i>Bureau of Public Roads</i> .....	THOMAS H. MACDONALD, <i>Chief</i> .
<i>Soil Conservation Service</i> .....	H. H. BENNETT, <i>Chief</i> .
<i>Weather Bureau</i> .....	C. C. CLARK, <i>Acting Chief</i> .

---

This circular is a contribution from

<i>Bureau of Plant Industry</i> .....	E. C. AUCHTER, <i>Chief</i> .
<i>Division of Fruit and Vegetable Crops and Diseases.</i>	H. P. GOULD, <i>Principal Horticulturist, in Charge</i> .











GPO 8-2432

JUN 17 1941

no. 476-500

Ac84C  
COP. 5

U.S.

U. S. DEPARTMENT OF AGRICULTURE  
LIBRARY

NOTICE TO BORROWERS

Please return all books promptly after finishing your use of them, in order that they may be available for reference by other persons who need to use them.

Please do not lend to others the books and periodicals charged to you. Return them to the Library to be charged to the persons who wish them.

The mutilation, destruction, or theft of Library property is punishable by law. (20 Stat. 171, June 15, 1878.)

Lib. 9



oro

8-7388

NATIONAL AGRICULTURAL LIBRARY



1022756918